The Launch Systems Operations Cost Model

Frank A. (Andy) Prince
NASA/Marshall Space Flight Center/Engineering Cost Office
andy.prince@msfc.nasa.gov

Introduction

One of NASA's primary missions is to reduce the cost of access to space while simultaneously increasing safety. A key component, and one of the least understood, is the recurring operations and support cost for reusable launch systems. In order to predict these costs, NASA, under the leadership of the Independent Program Assessment Office (IPAO), has commissioned the development of a Launch Systems Operations Cost Model (LSOCM).

LSOCM is a tool to predict the operations & support (O&S) cost of new and modified reusable (and partially reusable) launch systems. The requirements are to predict the non-recurring cost for the ground infrastructure and the recurring cost of maintaining that infrastructure, performing vehicle logistics, and performing the O&S actions to return the vehicle to flight. In addition, the model must estimate the time required to cycle the vehicle through all of the ground processing activities.

The current version of LSOCM is an amalgamation of existing tools, leveraging our understanding of shuttle operations cost with a means of predicting how the maintenance burden will change as the vehicle becomes more aircraft like. The use of the Conceptual Operations Manpower Estimating Tool/Operations Cost Model (COMET/OCM) provides a solid point of departure based on shuttle and expendable launch vehicle (ELV) experience. The incorporation of the Reliability and Maintainability Analysis Tool (RMAT) as expressed by a set of response surface model equations gives a method for estimating how changing launch system characteristics affects cost and cycle time as compared to today's shuttle system.

Plans are being made to improve the model. The development team will be spending the next few months devising a structured methodology that will enable verified and validated algorithms to give accurate cost estimates. To assist in this endeavor the LSOCM team is part of an Agency wide effort to combine resources with other cost and operations professionals to support models, databases, and operations assessments.

Background

NASA has recognized the problem of predicting reusable launch systems operations cost for many years. Early efforts include the Ground Operations Cost Model (GOCM), COMET/OCM, and the Operations Impact Assessor. More recent efforts are the Architectural Assessment Tool – evaluator (AATe), the Vision Spaceport Joint Sponsored Research Agreement, and of course, LSOCM. Other related efforts include a Macro Level Shuttle Processing Simulation Model, the Baseline Comparison Systems (BCS) database, and RMAT.

However, despite numerous attempts to understand the cost impacts of vehicle design, technology, and ground system definition, not one tool has proven to be the definitive product for determining the O&S cost of future launch systems. There are two simple reasons for this: lack of data and the size of the problem.

Traditional cost models rely on a database of like products that can be analyzed and used to develop cost estimating relationships (CER). In the case of reusable launch systems, only one has been successfully deployed: the Space Shuttle. Other programs that might have provided additional insight into O&S cost, such as X-33 and DC-X, were either cancelled or are too far removed from the capabilities required for an earth-to-orbit launch system to be of much use. To compound the problem, the data that is available on the shuttle is inconsistent in depth and coverage.

The Space Shuttle is a complex machine for a very good reason: it must be a rocket for launch, a spacecraft in orbit, and a glider for the return to Earth. Each of these roles imposes its own set of requirements that drive the vehicle design, and in turn, the O&S system necessary to support it. For example, the reusable ceramic tiles necessary to protect the shuttle from the extremely high temperatures of reentry are fragile, leading to many maintenance hours for repair, replacement, and waterproofing (which is done using a toxic chemical, which also increases the complexity and cost of operations). Yet these tiles are used for only a very small portion of the total mission.

The functions necessary to perform all O&S activities for a system like the shuttle often require unique facilities, valuable ground support equipment, and highly skilled people. To get a sense of all of the large number of functions required, the Spaceport Synergy Team at KSC put together a document called "A Catalog of Spaceport Architectural Elements with Functional Definition." Within this document, 12 generic spaceport functional groupings are identified. These are:

1. Payload/Cargo Processing
2. Traffic/Flight Control
3. Launch
4. Landing/Recovery
5. Vehicle Processing
6. Assembly/Integration
7. Depot Maintenance
8. Support Infrastructure
9. Unique Logistics
10. Operations Planning & Management
11. Expendable Elements
12. Community Infrastructure

Numerous functions are defined for each of the grouping with the vehicle concept determining which functions must be performed. All in all, the size of the O&S cost modeling problem is substantially larger than that typically faced by a hardware model development effort.

The LSOCM Team

As stated earlier, LSOCM is sponsored by the Independent Program Assessment Office (IPAO) at LaRC (Langley Research Center). The IPAO is chartered with providing independent analyses (including cost analyses) of NASA's programs and projects. The IPAO oversees LSOCM through the NASA Operations Cost Model Steering Committee. This committee has the responsibility of developing operations cost models for all of NASA's space flight hardware missions. To this end, the committee has successfully developed models for estimating the recurring operations cost of interplanetary and earth orbiting science missions. In addition to launch operations, efforts are currently underway to develop a model for human spaceflight operations.

The LSOCM team consists of operations, reliability & maintainability, and cost professionals from across NASA, plus contractor and university support. The current team members are listed below in Table 1:

NASA	SAIC	Old Dominion University
Andy Prince/Lead Doug Morris Nancy White Richard Brown Mike Nix Grant Cates Glenn Rhodeside Virginia Tickles	Mark Jacobs	Dr. Resit Unal Figen Baysel

Table 1. LSOCM Team Members.

Definition of Launch System Operations

Before proceeding further a definition of launch system operations needs to be established. As in all endeavors involving experts from various disciplines, semantic issues often arise to complicate the fruitful exchange of information. Therefore, a clear understanding of the key terminology used in this paper is important.

The first term to be defined is "launch system." The term launch system is used to capture everything required to place payloads and people into earth orbit. Generally speaking, everything can be divided into three major elements: the launch vehicle; the ground infrastructure necessary to support and maintain that vehicle; and offline functions such as payload processing.

The second term is "operations." Operations means the facilities, ground support equipment, people, and time required to perform all O&S activities necessary to maintain the launch system on the ground and in space. Purists from the maintenance and support world decry (with good reason) our liberal use of this term and the negative impact that has on learning anything from other organizations, such as the Air Force. However, we in NASA have been referring to what we do as operations for so long that I doubt change will occur soon.

Notice that there is some overlap in these two definitions. Both terms refer to ground infrastructure and facilities. The view taken in this paper is that "launch system" refers to a static collection of vehicles, buildings, GSE, etc. "Operations" is the act of putting these vehicles, buildings, GSE, etc. into productive use through people working over time. Neither definition captures the full scope of the problem. The proper design of a launch system requires that the complex and subtle interactions of the vehicle with the ground system be captured through the modeling of operations.

Requirements

A formal requirements document does not exist to support the development of LSOCM. A "Concept of Operations" document (model, not launch systems) is being developed as a precursor to a requirements document. In the mean time, a working set of requirements has been created to guide the modeling efforts. These requirements are as follows:

- Cost the operations of earth-to-orbit launch systems only.
- Be a general purpose model. That is, cover a wide range of launch vehicle concepts and technologies. However, the central focus is on reusable launch vehicles.
- Estimate all operations costs (see Generic Spaceport Functions)
- Estimate cycle time.
- Capture the following elements of cost:
  - Startup: facilities build, GSE purchase, and training.
  - Annual Recurring: facilities & GSE maintenance, fixed and variable labor and materials.

Initial Modeling Approach

A key goal in the development of LSOCM has been to correct one of the central shortcomings of other operations cost models: good at estimating what we do today (shuttle), not so good at estimating what we might do in the future. To overcome this shortcoming, LSOCM is built around two existing tools: RMAT and COMET/OCM.

RMAT provides a methodology for estimating the O&S cost for future launch systems. RMAT is not a cost model. However, RMAT does estimate reliability and maintainability requirements (number of maintenance actions, maintenance hours, etc.). The tool uses historical shuttle and military aircraft data to predict maintenance hours, turnaround time, and other metrics based on the vehicle design, choice of R&M characteristics, and choice of maintenance policy. By using military aircraft as an anchor point, RMAT provides insight into changes in the O&S burden as the vehicle becomes more aircraft like. RMAT operates at the subsystem level and is tailored to work on concept design studies.

However, RMAT has two drawbacks. The first is that RMAT only addresses the vehicle processing function. This leads to the inclusion of COMET/OCM to cost the other operations functions (more on that later). The second drawback concerns the ability of the model to estimate O&S improvement.

RMAT requires that the user make several subjective inputs concerning the amount of improvement in O&S to be realized by the new system relative to the existing system (shuttle). Normally, the amount (or level) of improvement is ascertained by numerous discussions with operations and vehicle design professionals. However, for LSOCM, the desire was to institutionalize the relationship between vehicle design characteristics, technology, and level of improvement. To get the necessary information it was decided to survey operations and vehicle engineering professionals. The survey provided some interesting results and enabled the initial version of LSOCM to estimate the amount of improvement in vehicle processing based on the vehicle characteristics and enabling technology. The survey process is discussed in greater detail below.

As stated above, COMET/OCM is the tool used to estimate the non-vehicle processing spaceport functions. COMET/OCM was developed for the Marshall Space Flight Center (MSFC) in 1994. The model is built on shuttle and ELV operations data, and enables the user to estimate the operations cost of shuttle derivatives, crewed reusable vehicles, uncrewed reusable vehicles, crewed expendable vehicles, and uncrewed expendable vehicles. While COMET/OCM enables a complete launch systems operations cost estimate, it does not adjust for improvements operations due to changes in technology or ground system infrastructure. Thus, using RMAT to estimate these improvements makes for a natural marriage of the two capabilities in LSOCM.

Two new algorithms are added to LSOCM. In order to provide part of the startup cost, facilities and GSE must be estimated. The model for estimating facilities and GSE cost is based on historical KSC actuals and has been adjusted to reflect improvements in technology. LSOCM translates vehicle size into facility sizes, which can then be estimated on a per cubic foot basis by using similar shuttle facilities.

Cycle time estimation is a new capability not readily available from any previous efforts. For the initial version of the model, cycle time is estimated for vehicle processing only. The algorithm uses maintenance burden hours, headcount, an accessibility factor, and amount of serial processing required.

Response Surface Modeling (RSM)

RMAT, like many powerful tools, is difficult to use, requiring experience and knowledge above and beyond that possessed by the average cost engineer. To simplify RMAT sufficiently for use in LSOCM (as well as to minimize the number of inputs), Dr. Resit Unal of Old Dominion University proposed the development of parametric models based on RMAT be derived via RSM techniques. This approach, fully described in the paper "Response Surface Model Building for Operational Characteristics of Reusable Launch Vehicle Concepts" and presented at this conference, has proven to be very successful in reducing the RMAT down to a small set of technical parameters. Dr. Unal will be doing additional work to determine which subsystem specific variables provide an improvement over the current models.

The result of the RSM development is a matrix of equations for each of the 21 subsystems modeled by RMAT. Each matrix consists of six vehicle size classes by 5 levels of improvement. The six vehicle size classes range from 120K to 280K pounds. The five levels of improvement start with current state-of-the-art and vary by 25% improvement increments until a maximum of 100% improvement (representing military aircraft like operations) is reached. The user inputs on vehicle size and level of improvement guide LSOCM to the correct equation in the matrix. Since it is likely the user inputs will lead to an estimated level of improvement somewhere between two of the preset levels, linear interpolation is used to get the correct outputs.

The inputs into the RSM equations consist of the following technical variables:

- Dry Weight (lbs)
- Length (ft)
- Wing Span (ft)
- Number of Engines
- Mission Duration (Days)
- Wetted Area (ft^2)
- Fuselage Area (ft^2)
- Fuselage Volume (ft^3)

The model outputs are reliability, number of maintenance actions, maintenance hours (divided into scheduled and unscheduled), and headcount (number of people who can work on the subsystem at any one time).

Survey

As stated earlier, one of the key issues when developing a reusable launch systems operations model is the lack of data. RMAT, by incorporating shuttle and military aircraft data, provides the endpoints. However, the rate and nature with which the operations cost changes as the vehicle changes is unknown. The purpose of the surveys was to get expert guidance in this area so that the model could be responsive to key design parameters.

The survey development process was iterative, with two test surveys being run before the survey instrument and presentation methodology was finalized. A portion of the survey illustrating the format is shown in Figure 1.

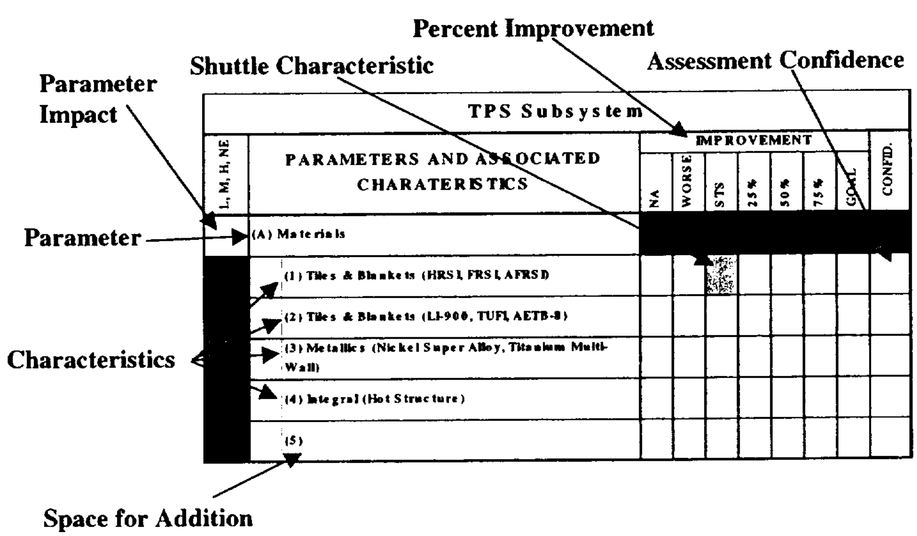

Figure 1. Survey Format

The following are the definition of terms and instructions for completing the survey:

Parameter: Operations or vehicle characteristic that is believed to have a major impact on operations.
Characteristics: Different aspects or features of the parameter.
Parameter Impact: Participant rating of the impact that this parameter has on O&S. Value could be Low (L), Medium (M), High (H) or No Effect (NE). If NE then the user would proceed to the next parameter.
Percent Improvement: The participant estimated impact on O&S for a given characteristic. NA is not applicable and would indicate that the characteristic has no impact.
Assessment Confidence: A one to five participant rating that gives the level of confidence in the assessed percent improvement. Five indicates the highest confidence.
Shuttle Characteristic: The characteristic indicative of the current shuttle system.
Space for Addition: The participant could add and assess missing characteristics (after all, this survey was designed by cost engineers!). There was also space available at the end of the survey for new parameters to be added.

Overall, 40 professionals from the operations, design, and cost fields were interviewed. The goal was to achieve a larger number of participants, but the time required to take the survey combined with a major KSC reorganization hindered participation.

Despite the problems, useful information was obtained from the surveys. For example, one interesting finding is that aircraft like operations using rocket based propulsion may be impossible. The results of the surveys have been used to develop input matrices for the model to determine the level of improvement for the RSM equations.

Model Operation

The current model is implemented in an Excel spreadsheet using macros, formulas, and action buttons. Various input sheets query the user for the information needed to run each of the model components. At this time, no attempt has been made to standardize the user interface, so parts of the model look and feel like COMET/OCM, other parts use input tables based on the survey results, and others are simple "fill in this cell" locations for necessary parameters. The model does have a built in data base capability to allow the user to save multiple estimates. However, this capability does not support editing of an estimate once it has been saved to the data base.

To simplify discussion, the model inputs are classified into types. These types are defined as follows:

Vehicle Description: Inputs that characterize the approach used by the launch system to place payloads into orbit. Queries include type of payload encapsulation, thermal protection system material, and main engine life.

Technical Data: Quantitative information such as that listed in the Response Surface Modeling section of this paper.

Flight Events: Number of significant flight events for each of three mission phases: ascent, on-orbit, and descent. LSOCM provides a predefined list of what constitutes a significant event. Examples include main engine start, docking, and de-orbit burn.

Propellants: Type and quantity of propellants used for each flight.

Flight Rate Profile: The expected number of flights per year for a 20-year period.

Time in Facility (non-Processing): The amount of time spent by the launch system in each of the three non-vehicle processing facilities: land/recover, launch processing, and flight operations.

Technology Effects: Percentage multipliers on the 21 RMAT subsystems that throughput the change in maintenance burden for a specific technology.

Each of the major LSOCM components uses different subsets of the inputs to generate different pieces of the operations cost picture. Table 2 shows these input and output relationships.

LSOCM Component	Inputs	Outputs
COMET/OCM	Vehicle Description Flight Events Propellants	Launch Cost Flight Operations Cost Propellant Cost
RMAT RSM Matrices	Vehicle Description Technical Data	Vehicle Processing Cost Vehicle Processing Time
Facilities Model	Launch Processing Time Mission Duration Vehicle Processing Time Flight Rate Profile	Number of Facilities Facilities & GSE Cost
Cycle Time Model	Launch Processing Time Mission Duration Vehicle Processing Time	Number of Vehicles Facility Utilization Turnaround Time

Table 2. LSOCM Input/Output Relationships.

Other outputs that can be obtained from the model include flight rate capability, headcount, and estimates for one and three shift operations (the model defaults to two shift operations). Of course, annual operations cost is provided, as shown in Table 3. Note that only the first three years of the 20-year model horizon are shown. Table 4 is a partial illustration of the summary level output. Two views of the data are given in Table 4: cost and cycle time by spaceport function; and cost by major element (facilities, GSE, etc.).

Launch System Operations Summary	Start-up	Year 1	Year 2	Year 3
Total Cost by Category				
Facilities	2,718	213	213	213
GSE	6,052	634	634	634
Spares, GSE	393	41	41	41
Labor	1,692	1,680	1,680	1,680
Variable	*735*	*732*	*732*	*732*
Fixed	*958*	*948*	*948*	*948*
Propellants & Fluids	12	11	11	11
Total Annual Cost	**$10,868**	**$2,580**	**$2,580**	**$2,580**
Average Cost/Flight, $M	**1,359**	**322**	**322**	**322**
Single Shift, Low Cost	***$10,022***	***$1,740***	***$1,740***	***$1,740***
Single Shift, Cost/Flight	***2,506***	***435***	***435***	***435***
Three Shifts, High Cost	***$11,714***	***$3,420***	***$3,420***	***$3,420***
Three Shifts, Cost/Flight	***976***	***285***	***285***	***285***

Table 3. Example Annual Operations Cost Output.

SPACEPORT SUMMARY	***Start-up***	***Avg Annual***	***LCC ****	***Avg Fleet-Level Days/Flight***
1-Processing	1,191	504	11,276	42
2-Launch	288	109	2,461	28
3-Flight Ops	1,009	604	13,097	5
4-Land/Recover	468	28	1,027	2
5-Support Infra	4,278	508	14,432	*n/a*
6-Payload Proc	290	130	2,885	*n/a*
7-Assy/Integ	2,235	228	6,787	*n/a*
8-Sys Plng&Mgt	1,109	470	10,501	*n/a*
TOTAL, $M	**10,868**	**2,580**	**62,466**	

COST ELEMENT SUMMARY	***Start-up***	***Avg Annual***	***LCC ****
Facilities	2,718	213	6,984
GSE	6,052	634	18,739
GSE Spares	393	41	1,218
Labor, variable	735	732	15,384
Labor, fixed	958	948	19,909
Propellants/Fluids	12	11	231
TOTAL, $M	**10,868**	**2,580**	**62,466**

Table 4. Example LSOCM Summary Output.

Of the 12 spaceport functional groupings discussed above, four are not estimated in LSOCM. These are Concept Unique Logistics, Expendable Hardware, Depot

Maintenance, and Community Infrastructure. The LSOCM team recognizes the shortcoming and plans to address these functional groupings in the near future.

Next Steps

While LSOCM is a functional model that gives reasonable results, much work remains before the model is sufficient to support NASA programs and projects such as 2nd Generation and Shuttle Upgrades. In the near term, the model development team is focused on the following four activities:

1. Perform Verification & Validation of the current version.
2. Upgrade the user interface.
3. Initiate the development of a generic simulation model.
4. Perform detailed planning for LSOCM Version 2.0.

Steps 1 and 2 are targeted towards the current version. Since several of the algorithms will be used in Version 2.0, it is important that the logic be validated and, to the best extent possible, the output verified. Also, upgrading the user interface will make the current model more accessible as well as providing a platform for testing the Version 2.0 interface.

Step 3 is focused on a new tool that will be an ancillary product with LSOCM, a generic launch system processing simulation model. Recent research by KSC has shown that a shuttle ground processing simulation can provide useful insight into operations activities. The purpose of the LSOCM generic simulation tool is to automatically create a ground processing simulation for a conceptual launch vehicle based on outputs from LSOCM. The generic simulation model will enable higher fidelity studies of launch system cycle times and facilities requirements.

Step 4 begins the process of developing LSOCM Version 2.0. One lesson learned from the development of the current version is that careful planning is important to success. Now that a version of the model is operational, it is easier to see the gaps and shortcomings. This knowledge is being used to guide the decision making process for determining what data and algorithms are needed for Version 2.0.

One major change for Version 2.0 is the work breakdown structure underlying the model. Currently, the 12 Generic Spaceport Functions are being used to determine what is and what is not estimated by the model. These 12 functions are an excellent catalog of the activities required to perform launch system operations. However, operations is by definition activity based; therefore, the LSOCM team has adopted a different operations paradigm designed to capture the flow of O&S as well as ensure completeness. This new paradigm is shown in Figure 2.

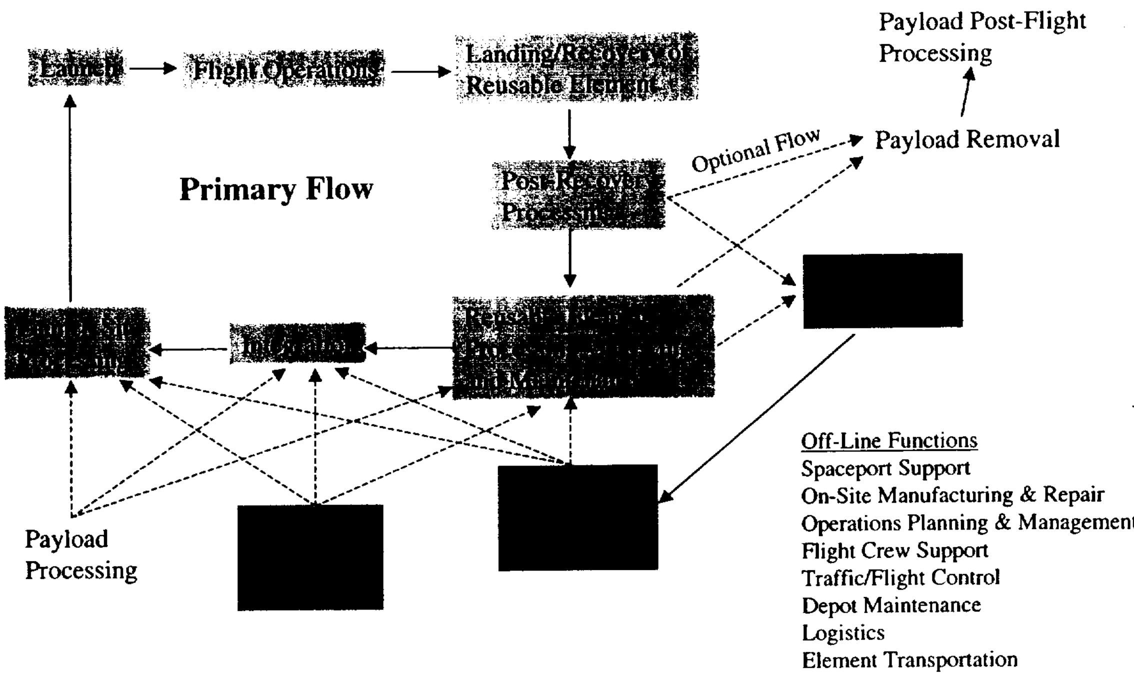

Figure 2. LSOCM Version 2.0 Paradigm.

An advantage of the new paradigm is that is shows launch system O&S as a series of activities, within each a logical grouping of functions can be performed. The paradigm also defines interactions between groups of functions, with optional flow paths illustrated by dashed lines. Other benefits of this paradigm are that it is a natural template for generic simulations and it allows the model to handle multiple vehicle elements by simply adding parallel functional groupings to the flow (i.e. a two stage to orbit vehicle would have a duplicate primary flow except for launch site processing, launch, and part of flight operations).

Conclusion

The current version of LSOCM is the first step towards developing a fundamental tool that NASA needs to support reusable launch vehicle studies. Other versions will follow, adding new capabilities and allowing more detailed analyses. The model will be used in the near term to support 2nd and 3rd generation RLV studies, and many ideas for enhancement are expected to result.

Support within NASA for improving the operations assessment and costing capability is strong. The Space Launch Initiative is well aware of the importance of credible O&S cost estimates in making decisions. Operations costing and assessment is vital to meeting the Agency goals of flying the shuttle safely, reducing the cost of access to space, and increasing reliability. LSOCM is being positioned as an important contributor to those goals.

Bibliography

1. General Dynamics Corporation for NASA/Marshall Space Flight Center: "Operations Cost Model (OCM & COMET) User's/Analyst's Guide." April 1994.

2. Highly Reusable Space Transportation Synergy Team: "A Catalog of Spaceport Architectural Elements with Functional Definition." October 1997.

3. Morris, W.D., et. al.: "Analysis of Shuttle Orbiter Reliability and Maintainability Data for Conceptual Studies." AIAA 96-4245, September 1996.

4. Morris, W.D., et. al.: "Defining Support Requirements During Conceptual Design of Reusable Launch Vehicles." AIAA 95-3619, September 1995.

5. Morris, W.D., et. al.: "Estimating Support of Reusable Launch Vehicles During Conceptual Design." 32nd Annual International Logistics Conference and Exposition, August 1997.

6. Space Propulsion Synergy Team: "A Guide for the Design of Highly Reusable Space Transportation." August 1997.

7. Unal, R., et. al.: "Response Surface Model Building for Operational Characteristics of Reusable Launch Vehicle Concepts." 3rd Joint Annual ISPA/SCEA International Conference, June 2001.

NASA Scientific and Technical Document Availability Authorization (DAA)

National Aeronautics and Space Administration

The DAA approval process applies to all forms of published NASA Scientific and Technical Information (STI), whether disseminated in print or electronically. It is to be initiated by the responsible NASA Project Officer, Technical Monitor, author, or other appropriate NASA official for all presentations, reports, papers, and proceedings that contain NASA STI. Explanations are on the back of this form and are presented in greater detail in NPG 2200.2, "Guidelines for Documentation, Approval, and Dissemination of NASA Scientific and Technical Information."

☐ Original
☐ Modified

I. DOCUMENT/PROJECT IDENTIFICATION

TITLE	AUTHOR(S)
Launch Systems Operations Cost Model	Frank. A. (Andy) Prince
ORIGINATING NASA ORGANIZATION: Systems Management Office/VS20 MSFC	PERFORMING ORGANIZATION *(If different)*

CONTRACT/GRANT/INTERAGENCY/PROJECT NUMBER(S)	DOCUMENT NUMBER(S)	DOCUMENT DATE

For presentations, documents, or other STI to be externally published (including through electronic media), enter appropriate information on the intended publication such as name, place, and date of conference, periodical, or journal name, or book title and publisher in the next box. These documents must be routed to the NASA Headquarters or Center Export Control Administrator for approval (see Sections III and VIII).

3rd Annual Joint ISPA/SCEA International Conference, July 12-13, 2001, Washington, D.C.

II. SECURITY CLASSIFICATION

CHECK ONE *(One of the five boxes denoting Security Classification must be checked.)*

☐ SECRET ☐ SECRET RD ☐ CONFIDENTIAL ☐ CONFIDENTIAL RD ☒ UNCLASSIFIED

III. AVAILABILITY CATEGORY

☐ ITAR ☐ EAR

Export Controlled Document - USML Category ______________ /CCL Export Control Classification Number (ECCN) ______________ *(Documents marked in this block must have the concurrence/approval of the NASA Headquarters or Center Export Control Administrator (see Section VIII).)*

☐ TRADE SECRET
☐ SBIR
☐ COPYRIGHTED

Confidential Commercial Document *(check appropriate box at left and indicate below the appropriate limitation and expiration):*

☐ U.S. Government agencies and U.S. Government agency contractors only
☐ NASA contractors and U.S. Government only
☐ U.S. Government agencies only
☐ NASA personnel and NASA contractors only
☐ NASA personnel only
☐ Available only with the approval of issuing office: ______________
☐ Limited until *(date)* ______________

☒ PUBLICLY AVAILABLE

Publicly available documents must be unclassified, may not be export controlled, may not contain trade secret or confidential commercial data, and should have cleared any applicable patents application process.

IV. DOCUMENT DISCLOSING AN INVENTION

THIS DOCUMENT MAY BE RELEASED ON *(date)*	NASA HQ OR CENTER PATENT OR INTELLECTUAL PROPERTY COUNSEL SIGNATURE	DATE

V. BLANKET RELEASE (OPTIONAL)

☐ All documents issued under the following contract/grant/project number ______________ may be processed as checked in Sections II and III.

☐ The blanket release authorization granted on *(date)* ______________

☐ is RESCINDED - Future documents must have individual availability authorizations.

☐ is MODIFIED - Limitations for all documents processed in the STI system under the blanket release should be changed to conform to block as checked in Sections II and III.

VI. AUTHOR/ORIGINATOR VERIFICATION			
I HAVE DETERMINED THAT THIS PUBLICATION: ☐ DOES contain export controlled, confidential commercial information, and/or discloses an invention for which a patent has been applied, and the appropriate limitation is checked in Sections III and/or IV. ☒ does NOT contain export controlled, confidential commercial information, nor does it disclose an invention for which a patent has been applied, and may be released as indicated above.			
NAME OF AUTHOR/ORIGINATOR Frank A. Prince	MAIL CODE VS20	SIGNATURE Frank A. Prince	DATE 4/26/01
VII. PROJECT OFFICER/TECHNICAL MONITOR/DIVISION CHIEF REVIEW			
☒ APPROVED FOR DISTRIBUTION AS MARKED ON REVERSE		☐ NOT APPROVED	
NAME OF PROJECT OFFICER OR TECH. MONITOR Joseph W. Hamaker	MAIL CODE VS20	SIGNATURE Joseph W. Hamaker	DATE 4-30-01
VIII. EXPORT CONTROL REVIEW/CONFIRMATION			
☒ Public release is approved ☐ Export controlled limitation is approved		☐ Export controlled limitation is not applicable ☐ Export controlled limitation (ITAR/EAR) marked in Section III is assigned to this document:	
USML CATEGORY NUMBER	CCL ECCN NUMBER	HQ OR CENTER EXPORT CONTROL ADMINISTRATOR *(as applicable)* W. H. NAbors	DATE 5/1/01
IX. PROGRAM OFFICE OR DELEGATED AUTHORITY REVIEW			
☐ APPROVED FOR DISTRIBUTION AS MARKED ON REVERSE		☐ NOT APPROVED	
NAME OF PROGRAM OFFICE REPRESENTATIVE Blanket Form Code R, NASA HQ	MAIL CODE	SIGNATURE	DATE 3/23/94
X. DISPOSITION			
THIS FORM, WHEN COMPLETED, IS TO BE SENT TO YOUR CENTER PUBLICATIONS OFFICE for CD10 Edward D. Medal Dominic Amatore 5-14-01 AD33/Joyce Turner Waits Joyce E. Turner Waits 05-16-01			

INSTRUCTIONS FOR COMPLETING THE NASA SCIENTIFIC AND TECHNICAL DOCUMENT AVAILABILITY AUTHORIZATION (DAA) FORM

Purpose. This DAA form is used to prescribe the availability and distribution of all NASA-generated and NASA-funded documents containing scientific and technical information (including those distributed via electronic media such as the World Wide Web and CD-ROM).

Requirements. The author/originator must provide either a suitable summary description (title, abstract, etc.) or a completed copy of the document with this form. This form is initiated by the document author/originator and that individual is responsible for recommending/determining the availability/distribution of the document. The author/originator completes Sections I through III, and VI. The author/originator is also responsible for obtaining information and signature in Section IV to the extent the document discloses an invention for which patent protection has been applied. Subsequent to completion of these sections, the author/originator forwards the document to the appropriate Project Manager/Technical Monitor/Division Chief for further review and approval in Section VII, including a re-review of the planned availability and distribution. Once this approval is obtained, the DAA is forwarded to the NASA Headquarters or Center Export Administrator for completion of Section VIII. It is then forwarded for completion of Section IX to the cognizant NASA Headquarters Program Office or Delegated Authority, who provides final review and approval for release of the document as marked.

When to Use This Form. Documents containing STI and intended for presentation or publication (including via electronic media) must be approved in accordance with the NASA STI Procedures and Guidelines (NPG 2200.2). Documents that are to be published in the NASA STI Report Series must be coordinated with the appropriate NASA Headquarters or Center Scientific and Technical Information Office in accordance with NPG 2200.2. Note that information on the Report Documentation Page (if attached) is not to be entered on the DAA except for title, document date, and contract number.

How to Use this Form. Specific guidelines for each section of this form are detailed below.

I. Document/Project Identification. Provide the information requested. If the document is classified, provide instead the security classification of the title and abstract. (Classified information must not be entered on this form). Include RTOP numbers on the Contract/Grant/Interagency/Project Number(s) line. Provide information on presentations or externally published documents as applicable.

II. Security Classification. Enter the applicable security classification for the document. Documents, if classified, will be available only to appropriately cleared personnel having a "need to know."

III. Availability Category for Unclassified Documents. Check the appropriate category or categories.

Export Controlled Document. If the document is subject to export restrictions (see NPG 2200.2, paragraph 4.5.3), the appropriate restriction must be checked, either International Traffic in Arms Regulations (ITAR) or Export Administration Regulations (EAR), and the appropriate United States Munitions List (USML) category or Commerce Control List (CCL), Export Control Classification Number (ECCN) must be cited.

Confidential Commercial Documents (Documents containing Trade Secrets, SBIR documents, and/or Copyrighted Information). Check the applicable box (see NPG 2200.2 paragraph 4.5.7). When any of these boxes are checked, also indicate the appropriate limitation and expiration in the list to the right of these restrictions. These limitations refer to the user groups authorized to obtain the document. The limitations apply both to the initial distribution of the documents and the handling of requests for the documents. The limitations will appear on and apply to reproduced copies of the document. Documents limited to NASA personnel should not be made available to onsite contractors. If the Available Only With the Approval of Issuing Office limitation is checked, the NASA Center for AeroSpace Information will provide only bibliographic processing and no initial distribution; CASI will refer all document requests to the issuing office.

Publicly Available Document - Unrestricted Distribution. Check this box if the information in the document may be made available to the general public without restrictions (unrestricted domestic and international distribution). If the document is copyrighted (see paragraph 4.5.7.3 in NPG 2200.2), also check the "Copyrighted" box in this section.

IV. Document Disclosing an Invention. This must be completed when the document contains information that discloses an invention (see NPG 2200.2, paragraph 4.5.9). When this box is checked, an additional appropriate availability category must be checked. Use of this category must be approved by NASA Headquarters or Center Patent Counsel or the Intellectual Property Counsel.

V. Blanket Release (Optional). Complete this optional section whenever subsequent documents produced under the contract, grant, or project are to be given the same distribution and/or availability as described in Sections II and III. More than one contract number or RTOP Number can be entered. This section may also be used to rescind or modify an earlier Blanket Release. All blanket releases must be approved by the Program Office or its designee and concurred with by the Office of Management Systems and Facilities.

VI. Author/Originator Verification. Required for all DAA forms.

VII. Project Officer/Technical Monitor/Division Chief Review. The Project Officer/Technical Monitor/Author or Originator Division Chief or above must sign and date the form. The office code and typed name should be entered.

VIII. Export Control Review/Confirmation. This section is to be completed by the authorized NASA Headquarters or Center Export Control Administrator for all documents.

IX. Program Office or Delegated Authority Review. This section is to be completed by the duly authorized official representing the NASA Headquarters Program Office. Any delegation from NASA Headquarters to a NASA Center in accordance with NPG 2200.2 should be entered here.

X. Disposition. For NASA Center use.

Joyce E. Turner
NASA-Marshall Spc Flt Ctr
~~MSFC, AL 35812~~
544-4528